A FURTHER REVIEW OF THE AVIAN FAUNA OF CHESTER COUNTY, SOUTH CAROLINA.

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CONCLUDING OBSERVATIONS ON MIGRATIONS.[1]

III. Migration Considered with Reference to Cause.

IN the study of bird migration we find two sources of causation — physical and psychological; the former embracing the conditions entailed by winter, cold and failure of food, necessitating southward migration and restraining northward; the latter, the adaptation to these conditions, implying education and probable heredity. The physical, as the primary or fundamental cause, will be considered first.

Physical Cause.—As a statement of the phenomena of migration is largely a statement of its physical cause, it may be well to pass in review the cycle of a year's migration.

June 20 may safely be said to mark the opening of the southward migration in this region, the scarcity of adult birds in a few species, whose breeding season is over, then becoming apparent. Mr. Brewster assures me that the date of inception of this early movement of adult birds in Eastern Massachusetts is about July 20 — a month later than in the Piedmont and Alpine Regions of South Carolina. In July, particularly toward the end, arrive the first Warblers that do not breed, so far as known, in Chester County. As the Southern Alleghanies are a part of their breeding habitat, the movement is presumably from these highlands. Breeding birds continue to depart during this month, and toward the close a few species have nearly or entirely disappeared, both the old and the young. In July, too, representatives of some of the species breeding here make their appearance from other localities, inaugurating the fluctuations noticeable in all the movements that follow, whether of breeding or of strictly transient species. The waves of migration become pronounced

[1] Concluded from p. 39.

by August. Fluctuations in breeding species — with marked intervals of paucity — are conspicuous features of the month's movements. Some of these birds of the breeding season, as the waves pass southward, rise in the scale of abundance, while others fall far short of their former numbers. Certain species that disappeared after their season of reproduction now reappear. A number of new arrivals make their appearance, mostly mountain breeding species, and birds whose first coming was in July occur at intervals in increased abundance, and at the close of the month late breeders begin to take their departure.

I have spoken of the early migration of Northern Phalaropes at Monterey Bay, California, and of a deflected movement of Dark-bodied and Pink-footed Shearwaters. On the 27th of June it was discovered that there was a considerable movement of California Murres going on. Like the Phalaropes and Shearwaters they moved rapidly southward parallel with the line of the coast. Aside from the California Murres, the July movements were confined, so far as determined by my observations, chiefly to the Western Gull and Heermann's Gull. In both the migration was one mainly of adult birds. The former species grew less and less numerous, and immature birds began to preponderate at the end of the month. Two large flocks of adult Heermann's Gulls, of both sexes, appeared on the 15th. They were the first I had seen, except several in dark plumage. As the month advanced adults rapidly increased. On the 27th I wrote in my journal, "This species is the most abundant Gull on the Bay. The dark phase, however, is not very plentifully represented, though birds of this style are becoming more numerous." California Murres continued to migrate south through July. Some days were days of marked migration. The first female was taken on the 11th. Females, however, did not become numerous until August, the earlier movements being apparently of males. July 18 an adult female Western Sandpiper was shot. On the 23d a few Wandering Tatlers appeared along the shore on the rocks just beyond the reach of the surf. A week later they were greatly reënforced, being generally distributed along the rocky shore. Their presence I attribute to migration. This assumption is corroborated by the character of the arrivals of the next few days.

August 1 the Northern Phalaropes appeared as reported. A Pomarine and a Parasitic Jaeger were taken, and a second specimen of the latter seen. There was a succession of California Murres, individuals and small parties in single file, passing down the coast, not nearer than a mile to the land, all the time I was out on the Bay, which was during the forenoon and midday. There was an equally great flight of Marbled Murrelets. They came rapidly from up the coast and disappeared to the southward. They flew usually in couples. There were young birds as well as old. Not more than half a dozen were seen on the water. The adults on the water took wing readily, but not so the hornotines, which dived to escape pursuit. The same was found true later in the Pigeon Guillemot. The young seemed to lack wing power, one Guillemot actually fell back into the water after getting partially under way. Such incidents afford a fair key in some cases to the seeming prior occurrence of young birds in the southward movement (the weak-winged drop out of the race), and emphasize the fact that departure from breeding grounds is the true criterion by which to determine the order of migration in the young and old. Dark-colored Heermann's Gulls outnumbered the adults, proving an influx in this species from another locality.

August 2, as I have stated, large numbers of Northern Phalaropes passed southward. Several Pomarine and Parasitic Jaegers were observed. In the California Murre and Marbled Murrelet there was a falling off, there being but slight movement in either. On the 4th occurred another wave of California Murres and the passage of Shearwaters described under deflected migration. Several Belted Kingfishers were noted on the 5th occupying rocks where the surf was not heavy. As only one had been seen previously about the Bay their presence was imputed to migration. The morning of the 6th many Pigeon Guillemots were found on the water just beyond the kelp. Most of them were adults. There had evidently been a movement during the night, for before this only six had been noted, and those birds-of-the-year during the latter half of July. Quite a number of Dark-bodied and Pink-footed Shearwaters were observed some three miles out from land. All were heading southward. In the middle of the day, flocks of Gulls passed

southward along the shore, not far out from the surf. Many were immature Western Gulls. The others were chiefly Heermann's. August 10 dark birds and those with mottled heads were the Heermann's Gulls principally seen. There was an extensive movement of Shearwaters on this day. As it was foggy many came within a mile of the land. The majority were several miles out, however. The bulk appeared to be the Dark-bodied. One Black-vented Shearwater was secured. About half a dozen Pomarine Jaegers were noticed. A good many companies of Northern Phalaropes were flying seaward. A few Marbled Murrelets were also migrating.

August 11 was a day of little migration. Just off the buoy at Point Pinos there was a great raft of Brandt's Cormorants on the ocean. This was the first gathering observed on the water, indicating that the rookeries were breaking up. There was a rookery south of Point Pinos. The 12th was the great day of migration in the Northern Phalaropes. There was a dense fog over the Bay in the morning, and it had the effect to crowd migration toward the shore. In my journal I find the following note on the California Murre: "Many groups and individual birds were scattered over the water. Their cries sounded strangely in the fog. Their migration was perhaps interrupted by it, as I have never seen so many before on the water." There was little movement manifested from the 15th to the 22d—my last day of observation. Up to the 16th only adult California Murres in breeding plumage were taken. On that day a single hornotine was secured, and on the 20th a second one. A pair of adults with mottled throats, etc., were shot on the 19th.

The occurrence in considerable numbers of White-winged and Surf Scoters (old birds) in June and July off the sandy beaches presents an interesting theme for inquiry. Of nine specimens shot June 23, all were females—seven of the former and two of the latter species. They were in very ragged and faded plumage. Some were unable to fly as the remiges had been moulted. The ovaries, too, were in a very low stage of development. These remarks will also apply to the condition of examples taken later. The only drake secured was a Surf Scoter, July 8. It remains to be determined whether such

early Scoters are, or are not, south-bound migrants. It is certain that the individuals captured were not wounded birds ('pensioners'), and on that account unable to perform the migration to their breeding grounds. Observations through May and June would throw light upon the matter.

A comparison between the southward movements of water birds in June, July, and August at Monterey Bay with those of the smaller land birds in Chester County discloses a striking similarity. There were the migration in some species of adult birds soon after their breeding season, the fluctuations, and the arrival of birds that breed wholly to the northward.

Mr. Murdoch speaks of early southward movements at Point Barrow, Alaska (Ray's Rep. Exped. to Pt. Barrow) occurring during the latter part of July. Judging from some of his annotations the first week of the month is perhaps the beginning of such migration. So far as definitely indicated, the adults migrated before the young.

The following from Dr. Coues's 'Notes on the Natural History of Fort Macon, N. C.' (Proc. Acad. Nat. Sci. Phila., 1871, p. 31) is so pertinent that I reproduce it in full: "The beach and marsh are cleared of all their sandpipers about the first of June; and, for some six weeks, scarcely a straggler of any sort is to be seen. But about the middle of July — a few days before or after the 15th — a few of this and the next species [Least and Semipalmated Sandpipers] reappear, and in August the numbers are materially increased, still in advance of the main body of September arrivals."

In Chester County, through September, breeding residents and residents fluctuate with the arrival and departure of waves. The majority of the former decrease permanently before the month ends, and some finally disappear. Except a single species, the last depart in October, several lingering almost to the end of the month. Many of the residents gain in abundance in September. Species whose advent was in August are then in the ascendency among transients. Their numbers vary as the successive waves pass southward. Extreme abundance is attained by some of the earlier transients. The additional species make their appearance chiefly after the first week. In most instances they come to their full measure of abundance in October. In October

winter species from the outset almost entirely supersede the transients as first arrivals. Usually a few transients still occur numerously at the middle of the month. Quite a number linger through the third week, some of them being fairly plentiful. The closing week stragglers only are to be found. With perhaps a few exceptions, the ordinary winter species are represented during the closing fortnight — some in abundance. During the first half of November most winter species reach their maximum abundance, which is followed by the decline to winter numbers. This diminution begins in a few even before October is gone. Stragglers linger into November, mainly birds that winter in the country below. A mild season tends to prolong their stay, and to induce certain other species to remain further north than is their wont.

So far as I have learned from the literature, migration in August, September, October, and November in the more northern Atlantic States does not differ in general character from migration in Chester County. There is difference in times of occurrence and in species. The Canadian element appears to be more prominent at the outset (Brewster, 'Bird Migration,' p. 16), and the later movements bring boreal birds that rarely if ever penetrate to the Carolinas.

At Point Barrow (Murdoch, l. c.) the height of the southward migration appeared to be through August and early in September. Until late in October, when the sea began to close, there was still some movement. Several swimming species remained in considerable numbers as long as there was any open water, as late as December.

In Chester County, December and January are months when the southward and northward movements contend for the mastery, there really being no cessation of migration, the migratory waves in some species, particularly those wintering mainly further north, setting alternately southward and northward as the weather is severe or mild. Snow has great influence on the ground-feeding birds in this locality as well as above it, covering up the food-supply and forcing them southward. Protracted warmth in these two months causes some winter species to grow scarce, while others that ordinarily winter more abundantly in the region immediately below are greatly reënforced, the north-

ward movement gaining the ascendency. These local occurrences appear to be a fair illustration of what takes place throughout the temperate portions of the continent under like meteorological conditions. The retarding of southward migration through warmth has been alluded to. In the 'Report on Bird Migration in the Mississippi Valley' (pp. 26, 27) an instance is cited as occurring during November and December, 1883, the effect of the mild season being reported in Dakota and in localities southward.

As has been seen southward migration is a gradual depopulation, beginning north and south before August and extending over nearly half the year. A survey of the bird fauna of the continent during the dead of winter shows that the great mass of bird life of the breeding season has been shifted southward, equalizing distribution so as to meet the conditions of winter. The hyperborean regions are depopulated, save by the few land birds that can find subsistence, the closing of the sea forcing water birds southward. As the supply of food is shorter in winter than in summer there is depletion through migration even in as hardy a species as the Snowy Owl. What transpires in Arctic regions also occurs in a lesser degree far to the southward. In the colder portions of the United States there is likewise the total migration of some species of the breeding season and the partial migration of others. Besides, there is the occupation of the territory evacuated by the birds that come from further north, that find food where insectivorous species would probably perish for lack of it, if not from cold. Upon the whole the aggregate of birds is greatly diminished. Further south, as in upper South Carolina, bird life is as abundant in winter as in summer, but the character is changed, insectivorous species, especially, giving place to those that are not dependent upon insects for food. The infrequency of snow in this region makes possible the presence of species in great abundance that occur only in limited numbers further north. As is the case to the northward, numerous resident species are less plentiful in winter than in summer. It should be observed that a species may be resident in the Middle States, or even further north, and yet be less numerous in the Piedmont Region of South Carolina in winter than in summer, there being migration at the South as

well as at the North in a species that is resident in both sections. The Blue Jay and Cardinal are examples. This obviously prevents over-crowding. Southern Florida, the Bahamas, West Indies, Mexico, Central and South America receive the surplus population from the northward. As the continental land area north of the Tropic of Cancer is so great, being about three times larger than that south of the Tropic of Capricorn, and as Central America and about half of Mexico are the only parts of the continent within the tropics, it is not surprising that the periodic flight from northern winter should extend far into South America.

In short, the population is lessened where the necessities are greatest, and changed in character where food is plentiful, apparently because the food is not suitable and because room is needed for those coming from above.[1] Whether it be the migration of the Plumed Partridge from the eastern slope of the Sierra Nevadas across the summit to the western slope, or whether it be the migration of the Brown-headed Nuthatch from the mountains of the Carolinas to the lower country, or of the adults of the Louisiana Water-Thrush before the close of June, or whether it be the migration of the American Pipit with the advent of snow, or of the Snowflake from hyperborean regions to the more northern portions of our country, or of

[1] The breeding land birds of temperate South America seem to find ready means of subsistence after summer without partial migration into North America, ample accommodation apparently being found by indigenous migrants, for there are indeed refugees from southern winter, numerous species migrating northward. See Sclater and Hudson's 'Argentine Ornithology.' The distribution of land probably accounts for the absence of such transmigration, for over two-thirds of the southern continent lie within the tropics. Among oceânic birds, Mr. Brewster has shown the high probability of a migration northward from an antipodean breeding habitat in at least one species of the family Procellariidæ; viz., Wilson's Petrel. See Proc. Bost. Soc. Nat. Hist., XXII, Oct., 1883, pp. 403, 404. Rev. A. E. Eaton's discovery of the breeding of this species during January and February on Kerguelen Island (Saunders's 'An Illustrated Manual of British Birds,' p. 730) bears out Mr. Brewster's conclusions.

There is some migration, at least, in breeding birds in tropical regions, but how far the presence of winter birds is compensated for has not been determined. Mr. Chapman mentions three species that are found in Cuba only during summer (Bull. Am. Mus. Nat. Hist., IV, p. 284), and Mr. Ridgway in writing of the migration of Hummingbirds (Rep. U. S. Nat. Mus. for 1890, p. 267) speaks of "slight migrations when the food supply of a given locality fails them, or when, on high mountains, the increasing cold forces them to descend to the warmer slopes and valleys."

Leconte's Sparrow from the interior to the South Atlantic States, or of the Bobolink in middle latitudes across the equator, or of the American Golden Plover from Arctic far toward Antarctic regions, the result is, that the life of the north is so adjusted that the dearth of winter is avoided.

The following description of the northward movement is based chiefly upon my 'Observations on Migrations' (Auk, IX, pp. 30–33) and upon the 'Study of the Bird Waves which passed up the Mississippi Valley during the Spring of 1884' (Rep. Bird Migr., pp. 25–37). While the southward movement, save in its latter stages in the case of prolonged warmth, is an uninterrupted evacuation of the region that cannot be held in winter, the northward movement is a reoccupation that is successively obstructed, interruption finally ceasing only when the bands of winter are broken in Arctic regions. Mallards, Canada Geese, etc., among water birds, Robins, Red-winged Blackbirds, etc., among land birds persistently press against the barrier of snow and ice, following in its wake as it recedes northward and retreating for the time being as it temporarily advances southward. Behind these come other birds of the same species in greater abundance, and White-throated, Song, and Field Sparrows, Killdeers, Wilson's Snipe, Meadowlarks, etc. Crowding upon these in turn come the hosts of highly insectivorous species, the last representatives of the earlier species, and those that habitually fetch up the rear of the migration. Migration may be arrested at the north and at the same time be under full headway at the south, movements taking place and territory occupied north or south as soon as it becomes tenantable, even though it be but temporarily so. So eager is the spirit to return that even the Swallows venture north before winter is hardly gone. At Saint Michaels, Alaska, according to Mr. Nelson (Rep. Nat. Hist. Coll., pp. 197, 198) the first Barn Swallows arrived during the latter half of May when the sea was covered with an unbroken surface of ice as far as the eye could reach. Frosty nights and snow-squalls were endured apparently without harm, shelter being found in old nests and other snug places until the sun shone once more.

Mr. Murdoch states (l. c., p. 116) that the spring migration at Point Barrow takes place from the middle of May to the end

of June. The first Snowflakes, however, appeared in April before the snow had really begun to melt and the King Eiders before there was any open water except the shifting 'leads' at a distance from the shore. Migration closes in Chester County about June 1, the decline being evident after the first week of May. It is significant that Mr. Scott reports boreal Sandpipers and Plovers in Florida as late as the first and second weeks of June (Auk, VI, pp. 156–159).

It will be observed that the repopulation of the continent occupies about the same length of time as the depopulation, nearly half the year.

Northward movement seems clearly not the starting point of migration. The first migration in all North American birds must be the southward. Evacuation is necessitated by winter, and as soon as the pressure of winter is in any measure relieved the return begins. At no time is there a beginning in the northward movement like that of the southward. The commencement of the southward and the ending of the northward movement are sharply defined, but the ending of the southward and the beginning of the northward are merged into each other — the two movements being contemporaneous for several months, the northward only achieving the supremacy after the repelling forces of winter have ceased to be potential. In brief, southward migration is esteemed to be enforced departure, and northward migration to be the earliest possible return of the birds to their home, to the region of their birth. Before pursuing this aspect of the subject further it is necessary to define the relation between cold and food-supply as affecting the later southward and earlier northward movements.

The abrupt departure of the bulk of Mockingbirds with the first cold snap in autumn (Auk, IX, p. 39) would seem to indicate that they find the cold uncongenial, and therefore migrate. On the other hand the fact that they are common winter residents in spite of the vicissitudes of weather seems to indicate that cold alone is not the cause of their migration. Many other species that are common or even abundant through winter are most numerous in spring and fall; the Flicker, Blue Jay, Meadowlark, and Myrtle Warbler being examples. It has been suggested that the more northern-born individuals of a

species are better fitted to pass the winter in the colder parts of their habitat than the southern-born, and are therefore the ones that linger farthest north. If mere northern birth fitted a bird for northern residence the Yellow Warbler that breeds abundantly even to the shores of the Arctic Ocean might be expected to winter further north than either its congener the Pine Warbler or the Mockingbird, and the Gray-cheeked Thrush might be expected to occur in winter in the same latitude at least as the Hermit. The circumstance that Mockingbirds from below hold their ground in the northward migration during far colder weather than that which prompted their departure in fall disposes of the idea that mere physical inability to withstand the cold is the cause of their removal. A species may be common south as well as common north of the region where the bulk winter. If temperature alone were the controlling influence the birds at the south of the centre of distribution must needs pass through and leave hehind the region best suited for their winter home. If cold then is not the immediate cause of removal in the instances cited, insufficiency in the food-supply may reasonably be assumed as the cause, not necessarily insufficiency other than that occasioned by the sojourn of winter residents coming from the north. To put the matter in another way, the partial passage further south of Mockingbirds and other winter species has apparently come about through the adjustment and equalization of distribution enforced by winter, the cold simply admonishing that the period of scarcity is at hand and that departure must no longer be delayed. The migration of breeding Robins from Chester County before the close of summer appears to be an instance of adjustment in a resident species occurring long before cold.

The Mallard migrates before cold in Missouri and yet in southern Greenland it is "Common the whole year round, but most numerous in winter, when they keep in small flocks along the shore" (Hagerup, Birds of Greenland, p. 17). The cold closes the water courses in the Mississippi Valley and locks up the food-supply for water birds, but in the latter region there is open water at the mouths of the fjords.

I have referred to the effect of snow upon the Robin, attributing its southward movements in winter to the covering up of the

food on the ground and not to inability to withstand the cold. Likewise I would account for the fluctuations in this region in the Prairie Horned Lark — snow further north sending them south when the increase occurs simply with cold. The American Pipit endures the severest cold of this region without migrating when the ground is bare, but when it is covered with snow they entirely disappear, immediately reappearing, however, with the disappearance of the snow. At Caddo, Indian Territory, in the winter of 1883–84 no Lapland Longspurs were seen until a sudden cold turn in February covered everything with frozen rain. Then they fairly swarmed for a week; at its end, "taking advantage of a clear sky and a south wind, they disappeared, in company with all their long-clawed brethren, as suddenly as they had come" (Rep. Bird Migr. Miss. Vall., p. 185).

Rapacious species naturally follow the vegetivorous species southward, and this, together with the covering up of other sources of food, seemingly explains the inroad of Red-tailed Hawks in the winter of 1886–87 (Auk, IX, p. 30). Warmth simply opens the way for northward migration. The failure of the Palm Warblers to appear when the Pine Warblers responded to the genial weather of December, 1889 (Auk, IX, pp. 28, 29) was, perhaps, partly due to the location of the winter isolated communities and partly to the main movement passing to the westward, as the species is much less abundant in spring than in fall. Besides failure from the covering up of the sea by ice there is said to be failure of food also at the north through the descent of certain marine forms of life to the lower depths, resulting in the migration of other forms—the dearth of the land through checking of vegetable and animal life by cold thus finding a parallel in the sea.

To sum up: It seems that cold in the winter migratory movements is but the remote cause, failure of food being apparently the immediate cause. Autumn movements within the bounds of winter habitat, as in the Mockingbird, seem to be anticipatory of failure of food, the cold simply warning dilatory migrants that the season of abatement in food has really come.

Variability in the occurrence of winter residents attributed to failure of food independent of sudden cold should be considered at this point. In studying southward migration at the southern

extremity of winter range, particularly in boreal species, variability arising from southward progression is not to be mistaken for variability arising from shifting in lines of movement. The southern limit of many winter birds is not sharply defined any more than the northern limit is, there being a sort of reserved ground between the extremes of southward movement of a species.

Where there is exceptional movement it is maintained that there is exceptional cause. Such movement and cause were well illustrated when the hordes of Prairie Horned Larks were forced south into this region in the winter of 1876–77, when the snow lay on the ground for a length of time unprecedented in my experience, covering up the food-supply so that the greatest abundance occurred in the wake of the snow, as it receded northward.

As great movements of Snowy Owls and Evening Grosbeaks take place when there is no unusual cold some other immediate cause than failure of food through sudden severity must be sought for. While local abundance in the Snowy Owl may not improbably be due sometimes to variability in lines of movement of isolated communities, coming from the southern frontier of the breeding range, the wide-extended invasion of the autumn of 1876 (Rep. Bird Migr. Miss. Vall., p. 123; Deane, B. N. O. C., II, p. 9) can only be imputed to unusual migration southward. Because the effect and not the cause of the movement was witnessed, there is no necessity for assigning it to the domain of inexplicable mystery. It should be kept constantly in mind that we view the migratory movements of this Owl from the southern portions of its range and that more than two thousand miles intervene between Grinnell Land, where it is reported as breeding abundantly, and the northern boundary of the United States. As the species is a regular seasonal migrant, it is not extraordinary that there should be variations in abundance in the United States, that the migrations of the numbers should be protracted further south in some seasons than others. The incursion of Robins in January, 1887 (l. c.) with the advent of snow, lessening the food area, proves that there may be migration at the South in a bird that thrives where the mercury freezes when food is plenty. Hence, if some Snowy Owls remain in the high

north, it is not disproved that there may exist urgent necessity for migration in the bulk of the species in a region further south. If the Snowy Owl does not visit the United States regularly in great numbers, neither does the Prairie Horned Lark visit South Carolina every winter in numbers equal to those of the season of 1876–77. As abridgment of feeding grounds is promptly met in the Prairie Horned Lark by protraction of migration, it would not be remarkable if there should be protraction of migration in the Snowy Owl, owing to temporary failure of food, though the cause of the failure be different. It is well authenticated that its presence in spring and summer in portions of Arctic regions is dependent upon the lemming (Murdoch, l. c., p. 107; Nelson, l. c., p. 153). Mr. Nash, as quoted by Mr. Thompson in 'The Birds of Manitoba' (Proc. U. S. Nat. Mus., XIII, p. 545), says, "During the winter of 1882–'83 they were very common. . . . In the winter of 1883–'84 they were less numerous; in the winter 1884–'85 very few were seen; the same in 1885–'86 as in the last three [two] mentioned years; hares were extremely abundant in the north; they probably found sufficient food to maintain them there." Insufficiency in food is ascribed as the cause of the exceptional extensions of this Owl into the United States, not unusual failure on the breeding grounds, but shortness in the region generally the limit of southward migration of the numbers. The vanguard appears to penetrate so far into the land of plenty, as to open the way for an early return, the beginning of the northward migration at the southern terminus not being long deferred in the majority. A counterpart is found in the brief sojourn of the Prairie Horned Larks in this vicinity (Auk, VIII, p. 57). The term of residence in all birds at the southern points of winter distribution is doubtless determined by the extent of the food area available to the northward.

In fine, exceptional movement in the Snowy Owl is interpreted as liberal adjustment of population to food-supply—adjustment in which emigration is not put off until actual starvation is imminent (because of unusual insufficiency in food in the ordinary winter range), but emigration which takes place in advance of such impending calamity and which extends far into the region of bountiful store.

The rarity of the Snowy Owl in the United States west of the Rocky Mountains is attributed to southeasterly migration,—the

mountain system perhaps giving the trend to the movement. The wandering of solitary Owls far south is not significant, the very fact of their being alone proving that they are stragglers.

The Evening Grosbeak presents peculiar conditions. It is a northern bird of southeasterly migration, and of erratic occurrence in the more southern and eastern portions of its winter range. Its uncertain visitations seem to be due more to extension of migration southward than to variation in lines of movement. The more local irregularities, however, may be due to such variability in location of isolated communities. The Great Plains on the south and the Barren Grounds and Hudson Bay on the north seem to give naturally a southeasterly trend to its migration. If the northern boundary of the strip of territory outlined be continued eastward the New England States would fall largely to the southward of it and would be in the path of a migratory movement following its general course. The Great Lakes, too, would appear to exert a deflecting influence. As southeasterly migration exists in Brewer's Blackbird, Leconte's Sparrow, etc., it is not an extraordinary circumstance that it should exist in this species also. As in the Snowy Owl, protraction of migration is attributed to shortness in food in the usual winter quarters. Its later stay is probably due to the different character of its food, the failure being more complete, and to its shorter fly-line, a smaller subsistence area being drawn from.[1]

The winter migratory movements have been attributed to covering up of the food-supply by snow and ice, and the autumn movements coincident with descent of temperature, as in the Mockingbird, have been explained as anticipatory of failure of food that would arise from over-population, owing to the presence of birds from further north. The movements of June, July, and August in this locality are obviously not occasioned by present failure of food, for migrants find subsistence long after the departure of breeding birds of the same species and often, too, in far greater numbers. These summer movements it is

[1] In the Western Evening Grosbeak, Pine Grosbeak, White-winged Crossbill, Redpoll, and Bohemian Waxwing it has not been determined, through want of precise data, to what extent irregular movements may be imputed to mere variability in location of isolated communities and to what extent to variability arising from protraction of migration.

plain remotely anticipate the failure of food of the winter season, for the birds must go sooner or later on account of winter. In order that the depopulation of the continent may not be a disastrous retreat, it must be gradual, must be an orderly evacuation. The later movements can be delayed, and winter birds can fluctuate with the advance and retreat of the ice and snow, for population has been so reduced through migration that means of subsistence are still to be found. Such would evidently not be the case if movement was deferred until famine was imminent. The vast population of the continent would be so crowded in the advance that food would fail. There could be no relief through scattering of forces, as in the Passenger Pigeon in the daily excursions after food in the region contiguous to a 'nesting.' In short, it is maintained that the only way that the depopulation could take place in an orderly manner is by gradual migration, beginning early in the season.

The question why some birds protract their migration southward and others do not should here be considered. Apparently other than climatic reasons must be sought. The American Golden Plover, Snowflake, Orange-crowned Warbler, Black-poll Warbler, Grinnell's Water-Thrush breed in Arctic regions. The Snowflake hardly reaches beyond the northern parts of the United States, but the American Golden Plover penetrates to Patagonia. The Orange-crowned Warbler winters as far north as the South Atlantic and Gulf States and Grinnell's Water-Thrush as the southern border of the United States, while the Black-poll Warbler is said to pass the winter entirely south of our limits. Difference in constitution[1] might explain why Snowy Owls remain within the Arctic Circle through winter and why the Yellow Warblers that breed there seek milder climes, but it does not explain why the Bobolink crosses the equator while the Phœbe endures the ice and snow in Upper South Carolina, nor why the Hermit Thrush winters

[1] The relative hardiness of different species is not easy of determination. If proneness to migration be taken as a criterion, the Robin, as a summer migrant from Chester County, would rank as a feebler bird than the Blue Grosbeak, and, in the vernal movements, the Black-poll Warbler, among the latest of transients in this region, than the Black-and-White Warbler, Blue-gray Gnatcatcher, and Yellow-throated Warbler, which are the first migrants to arrive in this locality that do not belong to winter species.

abundantly in the South Atlantic States and the Gray-cheeked Thrush passes on to Middle America,[1] nor why the Northern Phalarope is restricted to the Northern Hemisphere while Wilson's Phalarope continues its flight to Patagonia. The explanation I would advance is, that the present displacement and equalization of distribution through diversity in southward migration has been evolved through the process of time and is perpetuated by the requirements of winter. It is well known that birds can thrive far north of their usual winter habitat,[2] proving that extended protraction of migration is not a necessity except as there is need for general distribution, for there must be dispersion, and dispersion sufficiently wide-extended as to avoid the possibility of famine. All birds cannot exist in the same latitude *from sheer numbers*, no matter how abundant food may be.

There are extraordinary occasions where the adjustment does not prevent accident. During December, 1876, and January, 1877, the ground was covered with snow in this locality for over a fortnight, for a length of time greater than any in my experience. Old men recurred to many years before for a like event. Toward the end, and after the temperature had risen, there was great suffering among birds that find their living chiefly upon the

[1] While the Phœbe may possibly have a more plastic organism than other Fly-catchers of Eastern North America and therefore be better able to accommodate its diet to the food of the winter season, the Hermit Thrush does not appear to possess any such advantage over the Gray-cheeked Thrush. While passing through Chester County in fall, Gray-cheeked Thrushes feed, so far as I have determined, exclusively upon dogwood berries. Such food evidently agrees with them for they are often so fat as to be unfit for specimens. Dogwood berries are also a favorite diet with the Hermit and Olive-backed Thrush.

[2] The following instances illustrating the occurrence of individual birds in the colder months north of their customary limits are selected from this journal: Chimney Swift, Ottawa, Canada, first week in February, 1883 (W. L. Scott, Auk, I, p. 161). Yellow-bellied Flycatcher, Reading, Mass., Nov. 29, 1876; "the day was so cold that ice was forming rapidly in the shade"; stomach empty; "was very fat and apparently in the best of spirits": Newton, Mass., Dec. 1, 1876 (Allen, B. N. O. C., III, pp. 101, 102). Baltimore Oriole, East Templeton, Mass., Nov. 15, 1885; "in perfect plumage and condition"; "feeding upon frozen apples" (Ingalls, Auk, III, p. 135): Portland, Conn., Nov. 15, 1885 (Sage, *ibid.*). Louisiana Tanager, New Haven, Conn., Dec. 15, 1892; Lynn, Mass., Jan. 20, 1878 (Flint, Auk, X, p. 86). Maryland Yellow-throat, Cambridge, Mass., Jan. 31, 1890; "in beautiful plumage, and plump, although the mercury within a week had fallen to 5° F" (Faxon, Auk, VII, p. 409).

ground. Vesper Sparrows and others became so famished that children and dogs ran them down and captured them. That their weakness was not due to cold, but to exhaustion from want of food is shown by their enduring in other years, when there was no snow, even greater cold without apparent discomfort. Whether the birds that remained during the stress of weather were migrants from the north that could get no further, or whether they were winter residents whose previous experience, be it personal, traditional, or inherited, had shown that snow was of short duration in this region, is a matter undetermined. The American Pipits, however, were prompt to go, as is their custom, and there was partial migration early in other ground-inhabiting species. Mr. Mackay mentions an instance (Auk, IX, pp. 334, 335) where Old-squaws on the Massachusetts coast perished from lack of food owing to the prevalence of ice.

While northward migration is held to be but a return-movement, effected at the earliest moment, the conditions that prevent migratory birds from remaining in the regions visited during their migrations are not overlooked. Over-population and resultant struggle for existence alone would preclude them from becoming stationary in these regions.[1] This necessity for dispersion also forces them to return to the region of their birth. That birds should return to the same region to breed and winter is as necessary as migration itself, for if there was no definite destination in the majority of species there could be no uniformity of dispersal.

As is well known, climatic conditions are potential influences in distribution in the breeding season, the presence of boreal-breeding birds far south on high mountains is a striking example. Perhaps such conditions are equally potent in the migration of some species, other regions than those where they breed being unsuited to their needs.[2] Possibly concomitant alimentary con-

1 In the South Temperate Zone, winter and migration from the south in indigenous species would not only enforce the return of North American birds to their breeding habitats, but would also prevent any void occurring through their departure. It is not to be forgotten that there is some displacement at least of breeding birds by winter birds in the tropics (antea, p. 10).

2 Circumstances like the breeding of a pair of Myrtle Warblers in eastern Maryland (Kumlien, B. N. O. C., V, p. 182), the overlapping of the breeding ranges of northern and southern birds in mountains, and the wide-ranging in the breeding season of species like the Yellow Warbler, create a doubt whether conditions arising from

ditions are involved, particularly as pertaining to the food of the young. It is hardly to be supposed that there is any vital failure of food in the winter habitat (at least north of the tropics), for some species that are common in winter attain their greatest abundance, as migrants or breeders, after the departure of the winter sojourners of the same species.

In brief, the conclusion is reached that all southward migration in North America is depopulation because of winter, and all northward migration[1] is repopulation because of summer, the two great migratory movements being the adjustment of bird-life to the food-supply as ordered by the changing seasons—the food area decreasing with the progress of the sun southward, forcing birds to leave the region of their birth, and increasing with the progress of the sun northward, enabling them to return to it — to the region where the established equipoise between food-supply and distribution may be maintained and where the conditions arising from climate are perhaps better suited to the requirements of the breeding season.

Psychological Cause. — Having considered the physical causes of migration — those outer conditions on which migration depends — we come now in the second place to examine the psychological causes — those inner facts of bird life which have adjusted the migratory movements to the physical requirements.

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climate are insurmountable obstacles to successful reproduction in latitudes and altitudes higher or lower than the normal breeding range. Extension of range, however, might not be possible in such instances as the Myrtle Warbler, for the natives of the soil might be better fitted to survive than the interlopers in the contest that must inevitably ensue. In mountain regions the peculiar conditions may have rendered such contest more equal, resulting, in lapse of time, in the present overlapping. The absence of some boreal species on high mountains may be due to their inability to cope with other species except under the conditions prevailing in the region of their birth. Lack of powerful opposition may perhaps also account for the ranging of some birds, independent of altitude, farther north or south in certain regions than in others. As to the representatives that breed in high latitudes of species of wide-breeding-range, they may have become so modified as to find the environment in the southern portions of the breeding habitat uncongenial, but above and behind any such possible cause is the necessity for dispersion.

[1] While southward migration and northward migration are more appropriate terms than spring migration and fall migration, they do not cover altitudinal migration and migration in an east or west direction, though both are component parts of the two seasonal movements. Depopulating-migration and repopulating-migration seem more expressive designations.

In winter, as has been seen, there are physical conditions that force birds southward, which birds are prompt to recognize, and in autumn physical conditions that serve at least to admonish that it is time for the journey south to begin. In the summer movements, however, such incentives are wholly wanting. The pressure of migrants from further north, however potential it may be in some stages, is lacking in the first movements. How, then, does this adaptation to the necessity for early migration come about? Is the cause a mere blind impulse, inherited from ancestors? or is it the result of education, indirect from example, or direct through special instruction? Birds perform long journeys, following the outlines of landscape, occupying the same regions season after season with such regularity that life areas are defined with certainty. They adjust their winter movements to the ice and snow, and meet exceptional conditions by exceptional migration. These facts, indicating as they do that birds possess a high degree of intelligence, are incompatible with the theory that mere blind impulse is the cause of migration.

The conduct of wild birds in confinement, procured when young, was long ago pointed out by Dr. Bachman in his essay on migration (Amer. Journ. Sci. and Arts, XXX, 1836, p. 96) as evidence of inborn impulse. The spirit of restlessness spoken of may have been aroused, however, by the presence of other birds that were migrating at the time. Further, wild birds in captivity do not always exhibit such restlessness, as is attested by Mr. Watkins in the Evening Grosbeak (*fide* Butler, Auk, X, p. 157). Audubon says (Orn. Biog. III, p. 9) of a female Canada Goose raised from an egg taken from a wild bird, "At the period of migration she shewed by her movements less desire to fly off than any other I have known; but her mate, who had once been free, did not participate in this apathy." This species has become a 'classic' illustration of the alleged awakening of an irresistible desire for migration with the return of spring. It is now well established that there is continual migration in this and other species during the colder months, there being no sudden arousing of migratory impulse in their case at least. In mild autumns the later migrants delay their journey, lagging by the way, evincing that the impelling force in the continuance of their migration is from without and not from within. Still these facts

do not disprove that heredity may be an important factor in migration. The disposition for migration may be dormant or inoperative until awakened into action by the example or possibly by the instruction of older birds. The formation of woodland groups after the breeding season and their roaming through the woods is the first step toward migration in the young of many species. The gathering of the colonies of Red-winged Blackbirds in this locality into compact flocks and their desertion of the breeding marshes preliminary to their leaving is further illustration of the training that precedes migration, as also are the collection of Swallows and the establishment of 'summer Robin roosts,' such as described by Mr. Brewster (Auk, VII, p. 360). The departure of old birds does not leave the young without guidance, for the migration is a gradual depopulation. There are the belated breeders of the same species, the tardy breeders, the birds from localities further north, and those in which the young largely accompany the old, to serve as guides.[1] While the movements are scarcely perceptible when the old in woodland birds begin to disappear, when the young depart the current of migration is setting steadily southward. To the trained student of bird migration, the gatherings, their movements, and the notes of the migrants have a distinct meaning. How much more must the meaning be to the native birds of a locality. When migrants are arriving and departing, and when the air and woods and fields are filled with their voices, is it strange that the young should catch the spirit and join the movement southward? Having learned the way, is it remarkable that in subsequent seasons, as old birds, that they should become leaders and give inception to the migration? Want of experience, as well as probable lack of wing power, may have something to do with the tardiness of the young in the first season. While the spirit of migration may be hereditary, it is certain that southward migration is inaugurated and perpetuated solely by the experienced travellers. Whether the subsequent education of the young extends to an intelligent appreciation of the necessity for migration in the early southward movements, as is apparently the case in the winter and in the

[1] Guidance by veteran leaders in the northward migration is affirmed by Mr. Harvie-Brown in the case of 'Wild Geese' in the Outer Hebrides (Auk, VI, p. 271) and by Mr. Mackay in the Surf Scoter in New England (Auk, VIII, p. 283).

exceptional movements, can only be surmised. It is not too much to say that there is a common stock of knowledge, gained in the past and transmitted from generation to generation, that all adult birds possess.[1]

The stubbornness with which Warblers, etc., venture north in spite of freezing weather is not to be attributed, I think, to lack of intelligence, for it is not the cold of autumn followed by the dearth of winter that they encounter, but the brief cold spells of spring preceding the warmth of approaching summer with its abundance of food. Mere cold does not seem to have the effect that cold storms of wind and rain have, for hosts of Warblers endure freezing weather at the north late in May with apparent impunity (see Grundtvig, B. N. O. C., VIII, p. 67). The movements cannot be delayed until all obstacle is removed, because of numbers and lack of time. Then, too, there must be a definite time of starting, which, as has been seen, is as soon as territory is available for occupancy. The necessity of occupying all available territory is evident, so it happens that fall movements are delayed in mild seasons and advanced ground in winter, temporarily habitable, is taken possession of.

Physiological restlessness on the approach of the breeding season has been advanced as a cause of northward migration, but it apparently leaves unexplained the early winter movements. Further no such reason can be assigned for summer migration southward (though an opposite one might be), yet its inception occurs with the utmost regularity. Still it is not denied that the nuptial passion may exist when the knife does not reveal it, for it is not dormant even in south-bound transients in September and October. Neither is it altogether denied that desire for procreation may in a manner be a prompting influence in northward migration. It can hardly, however, be a paramount cause, independent of other causes, for it exists in sedentary species as well. 'Home affection' has also been put forward as the cause

[1] The following instance of young Passenger Pigeons succumbing to an emergency which old birds overcame is reported by Mr. Brewster on the authority of a Michigan Pigeon netter. "On one occasion an immense flock of young birds became bewildered in a fog while crossing Crooked Lake and descending struck the water and perished by thousands. The shore for miles was covered a foot or more deep with them. The old birds rosé above the fog, and none were killed" (Auk, VI, p. 289).

of northward movement. If this were the real cause birds of unstable local distribution, like the Dickcissel, would be without incentive, still they are regular migrants. *A cause must cover the whole ground to be the fundamental cause.* It is not unlikely that love of home is an important factor governing local distribution in many species, but causes that merely influence the selection of place of local abode are not to be confounded with the causes that occasion migration. As has been stated under 'Physical Cause,' northward migration is viewed simply as a return movement that is restrained only by the snow and ice. There are outward conditions that necessitate it. On the part of the birds, as in early southward migration, there is intelligent adaptation to these conditions — how far-reaching it is, and to what extent heredity enters as a factor, the limits of our present knowledge leave undetermined.

Finally, to sum up in brief the conclusions reached in the preceding remarks :—

(1) That migration begins with the southward movement, commencing south and north before August and progressing gradually, the two movements each extending over a period of nearly six months.

(2) That the young do not precede their parents in the southward movement.

(3) That all southward movement of birds is enforced departure from the region of their birth (enforced evacuation of territory capable in winter of supporting but a small portion of its summer life), and that all northward movement is return from exile at the earliest opportunity, necessitated by pressure from the south (by the need of dispersal and occupancy of all available food areas), and perhaps, in some species at least, by requirements as to climate during the breeding season.

(4) That the earlier southward movements are anticipatory, and necessarily so, and the later directly resultant of the conditions of winter.

(5) That irregular occurrence in winter birds is ascribed,

(*a*) To variableness in the location of isolated communities, independent of failure of food or severity or mildness of season.

(*b*) To sudden cold contracting the food area and forcing birds southward (cold being the remote cause and failure of food the

immediate cause), and to unusual protracted warmth enlarging the food area and encouraging birds northward.

(c) To failure of food independent of sudden severe cold.

(6) That extended protraction of migration southward and the partial passage further south of regular winter and resident species, that are uninfluenced by sudden ice and snow, are due to adjustment in distribution that prevents over-crowding, and not to climatic reasons.

(7) That fixity in destination in the majority of birds is as essential as migration itself, for without it there could be no uniformity of dispersion.

(8) That time, experience, and a high order of intelligence have brought about the adjustment necessitated by the physical conditions.

I have thus presented the facts observed during a long field experience and the conclusions and inferences that have suggested themselves in my endeavor to interpret them.

NOTES ON THE BIRDS OF PORT HENDERSON, JAMAICA, WEST INDIES.

BY GEORGE W. FIELD.[1]

THE beautiful island of Jamaica, though but a little larger in area than the State of Massachusetts, presents many diverse conditions affecting the local distribution of its bird-life. On account of the regularity with which these conditions are maintained, there is a remarkable uniformity in the species and numbers of birds found at any given locality. Chiefly on

[1] [An annotated list of the Birds of Jamaica, by Mr. W. E. D. Scott, was recently published in 'The Auk,' in instalments beginning with the number for October, 1891, and closing with the number for October, 1893. It is but just to Mr. Clark to state that the article here printed was received for publication in March, 1892, and has been unavoidably delayed. As Mr. Scott's observations were made in December, January, February, and March, and Mr. Clark's in May, June, July, and August, the two lists admirably supplement each other.—EDD.]